

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

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NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
(day/month/year)

19.11.2004

Applicant's or agent's file reference
P/2030.WOC/JW

IMPORTANT NOTIFICATION

International application No.
PCT/EP 03/08706

International filing date (day/month/year)
06.08.2003

Priority date (day/month/year)
06.08.2002

Applicant
XSIL TECHNOLOGY LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international
preliminary examining authority:



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PATENT COOPERATION TREATY

PCT



INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Article 36 and Rule 70)

Applicant's or agent's file reference P/2030.WOCJW	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP 03/08706	International filing date (<i>day/month/year</i>) 06.08.2003	Priority date (<i>day/month/year</i>) 06.08.2002
International Patent Classification (IPC) or both national classification and IPC H01L21/3065		
Applicant XSIL TECHNOLOGY LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 9 sheets, including this cover sheet.
 - ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:
 - I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application

Date of submission of the demand 19.03.2004	Date of completion of this report 19.11.2004
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Szarowski, A Telephone No. +31 70 340-4526 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP 03/08706

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*):

Description, Pages

1-3, 5, 6 as originally filed
4 received on 20.09.2004 with letter of 20.09.2004

Claims, Numbers

1-23 received on 20.09.2004 with letter of 20.09.2004

Drawings, Sheets

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

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EXAMINATION REPORT**

International application No. **PCT/EP 03/08706**

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	3-6,8,16,18-20,23
	No: Claims	1,2,7,9-15,17,21,22
Inventive step (IS)	Yes: Claims	none
	No: Claims	1-23
Industrial applicability (IA)	Yes: Claims	1-23
	No: Claims	none

2. Citations and explanations

see separate sheet

Re Item I

Basis of the report

The amendments filed with the letter dated 20/09/2004 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following:

1.1.

- **Claim 1** refers to "machining a silicon body (W) of a silicon wafer substrate" whereas the application contains only a basis for machining a silicon body (original claim 1) or a silicon wafer (see p.4, lines 15-17, line 24; p.5, line 1).
- No basis has been found for the extension to "a refrigerated liquid tetrafluoroethane" as page 4, line 8 refers to "a refrigerated liquid halide compound such as tetrafluoroethane", said wording being not considered as equivalent.
- Claim 1 refers to "a liquid comprising a mixture of halocarbons and other liquids". Said wording is to be found in the application at p. 5, lines 26-27 but is taken out of the context.
- Claim 1 refers in step d to "machining ... to form at least one of gaseous and solid by-products". This wording is not considered equivalent to the one of page 5, lines 8-10.

1.2.

- For the same reasons as the ones given for claim 1, **claim 12** introduces subject-matter having no basis in the application as filed.
- In addition claim 12 refers to an apparatus comprising "venting means arranged..." whereas the application contains only a basis for an apparatus comprising a gas vent.

1.3. As no basis for the above amendments has been found in the application as filed, the statement below is drawn up as if such amendments had not been made. In particular the claims have been analyzed as follows:

- claim 1 as original claim 1, wherein the laser is an ultraviolet or green visible wavelength laser and wherein a step e. has been added ("venting..."),
- claim 12 as original claim 11, wherein the laser is an ultraviolet or green visible wavelength laser and wherein a gas vent has been added,
- all claims referring to "a liquid halide compound or a refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids" as only referring to "a liquid halide compound".

1.4. Amended page 4 introduces subject-matter which extends beyond the content of the application as filed.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

- D1: LIM P ET AL: "LASER-ASSISTED LIQUID FILM ETCHING" APPLIED PHYSICS LETTERS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 62, no. 25, 21 June 1993 (1993-06-21), pages 3345-3347, XP000380997 ISSN: 0003-6951
- D2: WO 97/24768 A (PACIFIC SOLAR PTY LTD ;YOUNG TREVOR (AU)) 10 July 1997 (1997-07-10)
- D3: SVORCIK V ET AL: "LASER-STIMULATED ETCHING OF N-SI IN AQUEOUS SOLUTIONS" MATERIALS LETTERS, NORTH HOLLAND PUBLISHING COMPANY. AMSTERDAM, NL, vol. 9, no. 5/6, 1 March 1990 (1990-03-01), pages 204-206, XP000127337 ISSN: 0167-577X
- D4: PATENT ABSTRACTS OF JAPAN vol. 009, no. 100 (M-376), 2 May 1985 (1985-05-02) -& JP 59 225896 A (HANDOUTAI ENERUGII KENKYUSHO:KK), 18 December 1984 (1984-12-18)
- D5: WO 95/07152 A (HOLLMAN RICHARD F ;ELLIOTT DAVID J (US); SINGER DANIEL K (US); UVT) 16 March 1995 (1995-03-16)
- D6: EP-A-0 450 313 (IBM) 9 October 1991 (1991-10-09)
- D7: US 2002/050489 A1 (HAYASAKA NOBUO ET AL) 2 May 2002 (2002-05-02)

2. The application does not meet the requirements of Article 6 PCT, because claims 1, 6, 9-11 and 13 are not clear.

- Claim 1 aims at protecting a method of machining a **silicon body** whereas claim 9 aims at protecting a method "wherein machining a silicon body comprises machining a body containing a **significant proportion of silicon**". Claim 9 is in direct contradiction to claim 1 as the skilled person would only envisage a body constituted of silicon when reading claim 1.

- Additionally claim 9 is not supported in the sense that the information given in the application appears insufficient to enable the skilled person to extend the teachings of the description to all silicon-containing material on the basis of what has been described, in other words a method of machining a silicon body (Article 6 PCT). The same comments apply by extension to claims 10 and 11 depending on 9.
- Claims 1,6,12,13 are not clear. The claims and the description refer to "a liquid halide compound, a halocarbon and a tetrafluoroethane environment". However the skilled person would not refer to a hydrofluorocarbon as the one exemplified in the present application (tetrafluoroethane) as a "liquid halide compound", a halide being a binary compound. Additionally it is unclear through the application as a whole if the "halocarbon" itself is the possible "halide compound" or if the "halocarbon" is a particular component of the "halide compound environment" added in addition to the "halide compound" itself (see in particular page 4, lines 17-19). As a consequence, said terms jeopardize the clarity of the claims as a whole.
- The rest of this communication has been written as far as claims 1, 6, 9-11 and 13 can be understood.

3. METHOD / Claims 1-11

3.1. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 2, 7, 9-11 is not new in the sense of Article 33(2) PCT.

3.1.1. The subject-matter of claims 1, 2, 7, 9-11 is not new with respect to D1. D1 discloses (p.3345-3346; fig. 1,2) a method of machining a silicon body with a green visible wavelength laser comprising providing a liquid halide compound environment (hydrofluoric acid) in at least a machining location of the silicon body by condensing a HFA vapor; directing the laser beam at the machining location of the silicon body in the liquid halide compound environment; locally heating the liquid halide compound with the laser beam in the vicinity of the machining location to cause a chemical reaction between the silicon body and the liquid halide compound at the machining location; machining the silicon body at the machining location with the laser beam thereby causing the chemical reaction to take place at the machining location; venting any gaseous by-products from the environment of the liquid halide compound and dispersing any solid by-products in the liquid halide compound.

3.1.2. The subject-matter of claims 1, 2, 9-11 is not new with respect to D2.

D2 discloses (p. 4 line 4 - p.5 line 5; p. 8; p.10, lines 11-35) the machining of a silicon body with an UV or a green wavelength laser beam, comprising simultaneously grooving, cleaning and doping the silicon body in a mixture of Cl_2 and BCl_3 . BCl_3 condenses providing a liquid halide compound environment in a machining location, and the laser reevaporizes the liquid in said location.

Even if not explicitly stated in D3, there is no doubt that the chlorine released from BCl_3 reacts with the silicon, as the Cl_2 does (see p.8, lines 28-29).

(D2 discloses machining in a liquid halide compound environment as only the location exposed by the laser beam is reevaporized.)

3.1.3. The subject-matter of claims 1, 2, 9-11 is not new with respect to D3.

D3 discloses the machining of silicon in solutions of KHF_2 and NH_4HF_2 salts assisted by UV laser. Even if not explicitly stated in D3, local heating of the liquid with the laser beam in the vicinity of the machining location occurs.

3.2. Dependent claims 3-6, 8 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step (Article 33(3) PCT).

- Claim 3, 4: according to circumstances the skilled person would refrigerate the liquid if required.
- Claim 5: delivering a liquid compound using aerosol nozzle means is common.
- Claim 6: D4 discloses (abstract; fig. 1, 2; par. 8) a method of machining a silicon body with an infrared laser beam (60), comprising providing a liquid freon compound environment in at least a machining location of the silicon body ("...F, Cl generated by the working are brought into reaction with the part irradiated with the laser beam by which the material melted and scattered by the grooving is evaporated..."). The skilled person would naturally envisage to use said freon with other types of lasers according to circumstances.
- Claim 8: laser machining vias, dice lanes and scribe lanes is commonly known and the skilled person would also envisage using the chemically-assisted method for the same purpose.

4. APPARATUS / Claims 12-23

4.1. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 12-15, 17, 21 and 22 is not new in the sense of Article 33(2) PCT.

4.1.1. The subject-matter of claims 12-15, 17, 22 is not new with respect to D1 disclosing (fig.1, 2) a laser machining apparatus comprising a green visible wavelength laser; means for directing a laser beam from the laser onto a machining location; means for providing a controlled liquid halide compound environment around at least the machining location; and a gas vent.

4.1.2. The subject-matter of claims 12-15, 21 is not new with respect to D5 disclosing (p. 35-38, fig. 12; p. 54, line 18 - p. 55, line 7, fig.19) a laser machining apparatus comprising a green visible wavelength laser.

It is reminded that an apparatus having specific technical features and further characterized by the method realized and/or the material processed is not new with regards to another apparatus having said features to the extent that this apparatus is suitable for carrying out said method and/or processing said material.

4.2. The subject-matter of claim 12 does not involve an inventive step in the sense of Article 33(3) PCT.

- D6 discloses (col.4, line 29-col.5, line 7; fig.1) a laser machining apparatus comprising a green visible wavelength laser.

The subject-matter of claim 12 differs in that a gas vent is provided.

The skilled person would however regard it as a normal design option to include such a venting means in the apparatus of D6 according to circumstances.

The same reasoning applies with respect to D7 (fig. 2; par. 50-68) disclosing a laser machining apparatus comprising an ultraviolet or green visible wavelength laser.

- D4 discloses (abstract; fig. 1) a laser machining apparatus comprising an infrared wavelength laser, means (51) for directing a laser beam (60) from the laser onto a machining location; means (29, 53, 54, 55, 56) for providing a controlled liquid compound environment; and a gas vent.

The subject-matter of claim 12 differs in that the laser emits an ultraviolet or a green light wavelength.

According to circumstances the skilled person would however naturally envisage to replace said YAG laser by another type of laser.

4.3. Dependent claims 16, 18-20, 23 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

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- Claim 16: laser apparatus equipped with inlet and outlet ports for a liquid and a gas vent are known (see for example D4).
- Claim 18: it is common in the field of laser processing to provide a window which is anti-reflection coated.
- Claims 19, 20: the skilled person would adapt the apparatus of claim 12 to provide refrigeration means.
- Claim 23: telecentric lens means for directing the laser beam are commonly known in the field of lasers (see D1, D4, D5, D6, D7).

5. Claims 1-23 satisfy the requirements of Article 33(4) PCT.

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Conveniently, the laser machining apparatus further comprises telecentric lens means for directing the laser beam, wherein a flow of the refrigerated liquid halide compound substantially fills a field of view of the telecentric lens means.

5 The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:-

Fig. 1 is a perspective schematic view of a laser machining apparatus according to the invention; and

Fig. 2 is a plan view of the apparatus of Fig. 1.

10 In the figures, like reference numerals represent like parts.

Referring to Figs. 1 and 2, a laser machining apparatus 1 comprises a stainless steel enclosure 2 having a liquid inlet 3, a liquid outlet 4, and a gas vent 5. An optical system 10 is mounted above the enclosure. An enclosed liquid bath is completed by an anti-reflection coated window 15 transparent to the laser beam to allow access of a UV laser beam to a silicon wafer W in the bath. Alternatively, a laser emitting green visible light may be used.

15 In use, the wafer W is placed in the enclosure 2 and a refrigerated liquid halide compound or tetrafluoroethane is pumped into the bath via the inlet 3. Alternatively, some other liquid halide compound, in particular a liquid halocarbon, producing a halogen such as fluorine, chlorine, bromine or iodine, may be used. The inlet 3 and the outlet 4 are in a refrigeration circuit so that the liquid temperature is maintained at or below the gas transition temperature of the particular liquid halide compound. The bath is at least partially filled with the liquid.

20 The temperature of the substrate W to be machined and the temperature of the active fluid may be controlled before, during and after machining in order to improve the efficiency of machining and also to improve the quality of machining.

Claims

1. A method of machining a silicon body (W) of a silicon wafer substrate with an ultraviolet or green visible wavelength laser beam (6), comprising the steps of:
 - a. providing an environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids in at least a machining location of the silicon body;
 - b. directing the laser beam at the machining location of the silicon body in the environment of the liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids;
 - c. locally heating the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids with the laser beam in the vicinity of the machining location of the silicon body sufficiently to cause a chemical reaction between the silicon body and the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids at the machining location;
 - d. machining the silicon body at the machining location with the laser beam, thereby causing the chemical reaction to take place at the machining location to form at least one of gaseous and solid by-products; and
 - e. venting any gaseous by-products from the environment of the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids and dispersing any solid by-products in the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids.
2. A method as claimed in claim 1, wherein the step of providing the environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids comprises providing an environmental chamber (2) for containing the

liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids.

3. A method as claimed in claims 1 or 2, wherein the step of providing the environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids comprises providing a refrigerated liquid halide compound or a refrigerated liquid comprising a mixture of halocarbons and other liquids.
4. A method as claimed in claim 3, wherein the step of providing the refrigerated liquid halide compound or the refrigerated liquid comprising a mixture of halocarbons and other liquids comprises controlling a temperature of the refrigerated liquid halide compound or the refrigerated liquid comprising a mixture of halocarbons and other liquids before, during and after machining.
5. A method as claimed in any of the preceding claims, wherein the step of providing the environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids comprises providing aerosol nozzle means for delivering the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids to at least the machining location.
6. A method as claimed in any of the preceding claims, wherein the step of providing the environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids comprises providing a halocarbon containing a halogen selected from the group of fluorine, chlorine, bromine and iodine.
7. A method as claimed in any of the preceding claims, wherein the step of machining the silicon body comprises controlling a temperature of the silicon body substantially to prevent thermal damage to the silicon body by controlling thermal loading of the silicon body.
8. A method as claimed in any of the preceding claims, wherein the step of machining the silicon body comprises machining at least one of a via structure, a dice lane and a scribe lane in the silicon body.

9. A method as claimed in any of the preceding claims, wherein machining a silicon body comprises machining a body containing a significant proportion of silicon.
10. A method as claimed in claim 9, wherein the step of machining a body containing a significant proportion of silicon comprises machining a multilayer structure.
11. A method as claimed in claim 10, wherein machining a multilayer structure comprises machining a multilayer structure having a plurality of layers of semiconductor, metal, interlayer dielectric and ceramic materials.
12. A laser machining apparatus (1) for machining a silicon body of a silicon wafer substrate comprising: an ultraviolet or green visible wavelength laser; means (2) for providing a controlled environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids in at least a machining location of the silicon body; means (10) for directing a laser beam (6) from the laser onto the machining location locally to heat the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids with the laser beam in the vicinity of the machining location of the silicon body sufficiently to cause a chemical reaction between the silicon body and the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids at the machining location and to machine the silicon body at the machining location with the laser beam, thereby causing the chemical reaction to take place at the machining location to form at least one of gaseous and solid by-products such that any solid by-products are dispersed in the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids; and venting means (5) arranged to vent any gaseous by-products from the environment of the liquid halide compound or refrigerated liquid tetrafluoroethane or the liquid comprising a mixture of halocarbons and other liquids.
13. A laser machining apparatus as claimed in claim 12, wherein the means for providing the controlled environment of a liquid halide compound or

refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids is arranged to provide a controlled liquid halocarbon environment.

14. A laser machining apparatus as claimed in claims 12 or 13, wherein the means for providing the controlled environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids comprises environmental chamber means.
15. A laser machining apparatus as claimed in claim 14, wherein the environmental chamber means comprises bath means for a refrigerated liquid halide compound.
16. A laser machining apparatus as claimed in claims 14 or 15, wherein the environmental chamber means comprises an inlet port (3) and an outlet port (4) for the liquid halide compound, and a gas vent (5).
17. A laser machining apparatus as claimed in any of claims 14 to 16, wherein the environmental chamber means comprises a window (15) transparent to the laser beam for entry of the laser beam (6) into the environmental chamber means.
18. A laser machining apparatus as claimed in claim 17, wherein the window is anti-reflection coated.
19. A laser machining apparatus as claimed in any of claims 14 to 18, comprising refrigeration means for providing a refrigerated liquid halide compound or a liquid comprising a mixtures of halocarbons and other liquids to the environmental chamber means.
20. A laser machining apparatus as claimed in claim 19, wherein the refrigeration means is arranged for controlling a temperature of the liquid halide compound or the liquid comprising a mixtures of halocarbons and other liquids before, during and after machining.
21. A laser machining apparatus as claimed in any of claims 12 to 20, wherein the means for providing the environment of a liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids comprises aerosol nozzle means for delivering

the liquid halide compound or refrigerated liquid tetrafluoroethane or a liquid comprising a mixture of halocarbons and other liquids at least to the machining location.

22. A laser machining apparatus as claimed in any of claims 12 to 21 comprising temperature control means for controlling a temperature of the silicon body (W) to be machined at the machining location, arranged substantially to prevent thermal damage of the body by controlling thermal loading of the silicon body.
23. A laser machining apparatus as claimed in claim 19, further comprising telecentric lens means for directing the laser beam, wherein a flow of the refrigerated liquid halide compound substantially fills a field of view of the telecentric lens means.